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ABSTRACT

Thinkback is a new instructional process that uses "thinking aloud" strategies developed by Arthur Whimbey and derives its name from the technology of instant video playback. Thinkback is a generalization of techniques described in the program "Problem Solving and Comprehension," which has been used for more than 20 years. The key element of the program is Thinking Aloud Pair Problem Solving (TAPPS), a process wherein a listener asks questions that probe the problem solver's thinking. The Thinkback technique spans the gap between unstructured constructivist-style instruction and lock-step memorization drills, and it can convert a teacher-centered rote memory lesson into an intellectually challenging student-centered exploration while simultaneously maintaining specific content mastery objectives in areas such as mathematics, language arts, social studies, or science. Thinkback can also be used to add subtle structure to an open-ended creative exercise, thereby allowing students at all ability levels to benefit from the exercise. Before students begin the TAPPS process, they are presented with a model case consisting of dialogue between a problem solver and a listener. As a student gains experience, the listener's questions become increasingly probing. The process culminates in reflective thinking, the ability to listen to and follow one's own thought process. (MN)

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Crossroads of the New Millennium

Sound Thinking With Thinkback 2000

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Abstract

Thinkback is a powerful new instructional process which employs the "Thinking Aloud" strategies of Dr. Arthur Whimbey. It can be applied to topics in: mathematics, language arts, social studies and science. **Thinkback** spans the wide gap between unstructured constructivist-style instruction and lock-step memorisation drills. The **Thinkback** technique can convert a teacher-centred rote memory lesson into an intellectually challenging student-centred exploration, while, at the same time, maintaining specific content mastery objectives. Or it can be used to add subtle structure to an open-ended creative exercise, allowing students of all levels to benefit and ensuring that no one is left floundering.

Thinkback: *A User's Guide to Minding the Mind* is the only text currently available that contains detailed models of metacognitive dialogues in the classroom. These dialogues enable teachers and teacher educators to observe a thinking process that previously had been invisible and undetectable. Based on over 20 years of careful cognitive research, the dialogues provide teachers with important insights into the nature of thinking and problem solving.

Sound Thinking With Thinkback 2000

UNLOCKING THE HUMAN MIND

Traditional modes of education were designed for cultures and economies where success was dependent on static knowledge. In the evolving social structures and global economy of the new millennium, success will depend on developing human contacts and on finding new knowledge as needed. Current models of education provide poor preparation for this new world. Until quite recently, a primary function of education was to discourage thought. In colonial times, for example, education systems were designed to maintain the coloniser's control over the colony. In Imperialist states, education was employed to maintain the status of a small ruling elite. In some cases the restrictions were quite explicit. In South Africa, prior to 1990, the Department of Education and Training had the specifically stated goal of limiting the thinking skills of all black Africans. But today few countries can afford a DET regime. All societies face the relentless demands of a rapidly changing knowledge economy. To be competitive in the world they must strive to develop fully the thinking skills of every single citizen.

Unfortunately, experience with education systems of the past continues to colonise our minds. It is very difficult to shake off beliefs and assumptions we grew up with. We fail to see the ways in which outmoded systems paralyse our students' mental potential. Our goals have changed but our tools have not. In this new millennium it is time we sought new methods and techniques for learning. More accurately, as Stigler and Hiebert (1999) point out, we need to find a new culture of teaching.

The information economy demands *dynamic knowledge*, knowledge about how information can be found, manipulated and shaped to specific needs. To keep pace with these demands students need to understand the workings of their minds and know how to train and discipline those processes to accomplish specific purposes.

Furthermore, the demands of the global marketplace require constantly higher levels of performance. New categories of students with widely varied preparations must now be

provided advanced educational opportunities. Classic European systems, originally conceived to maintain the dominant class and colonial authority, are ill equipped for this task.

Education systems no longer can select the best and reject the rest.

THE KEYS TO BETTER MANAGING THE MIND

Learning is often accomplished through imitation. Parents act; offspring imitate. This is how birds learn to fly, cats learn to hunt and human children learn to walk and talk. But thinking is very difficult to imitate because it is nearly impossible to "see" it happening. What we see are the results not the process. Imagine how hard it would be to learn to play a sport if the only part of the sport you could see was the score board. All the action would be invisible. You would have no idea of the number of players or of the rules. Occasionally you might hear a cheer and see some numbers on the score board change. The chances are good that you would soon lose interest.

Thinkback provides insight into the thinking process. It is a new kind of learning named after instant video **playback**, which has revolutionised sports. With video playback players get immediate feedback on how they performed by watching their own actions from a perspective they could never achieve without the aid of a camera and video tape. They can be coached by an expert who can play back their actions in slow motion and demonstrate frame by frame where a motion was appropriate and where it was ineffective. Referees can replay their last call and rethink their last decision. Fans can watch the best (and worst) plays over and over: learning, gloating and groaning.

Thinkback is also a generalisation of techniques described in *Problem Solving and Comprehension*, a programme with over 20 years of success and research behind it. The key element of this programme is Thinking Aloud Pair Problem Solving (TAPPS), a process that provides for thinkers and their minds what the video camera and tape player provide for athletes and their bodies.

SOUND THINKING WITH THINKBACK

Imagine playing a game of tennis in the dark. You see nothing. Out there somewhere in front of you is the net. Suddenly you hear the sound of a racket hitting the ball, followed by the sound of the ball bouncing in your court. You take a step toward where you think the bounce may have been and swing your racket. In the very unlikely event that you hit the ball you get little sense of where it goes or lands.

Not many people have attempted to learn tennis in the above manner. Yet we use a similar strategy to teach thinking. Thinking is invisible and inaudible; normally it is not accessible to any of our senses. Yet we seem to forget this when we teach thinking. Most often the teacher demonstrates how to solve a problem by using a largely invisible method.

We usually learn skills by observing experts as well as by observing our own efforts. We attempt to determine the differences between our efforts and those of skilled performers and then we try to modify our efforts to make them more like the experts'. Thus a student of tennis will watch superior players as they hit balls. He will then try to swing his racket in a similar manner and may have a coach watch and critique these attempts. The coach will tell the student to pay attention to particular parts of the swing, and she may even guide the swing by physically holding and pushing the learner's arms. Advanced athletes compare their actions, as recorded on digitised video tape, to computer models and may thereby improve skills beyond those of any previous human. It seems reasonable to apply a similar approach to thinking. Unfortunately such an approach can only work if the learner can observe both his or her own thinking and that of the teacher's. But thinking is invisible! More accurately, thinking is not sensible until we act to make it detectable to at least one of five senses. Sound is usually the simplest sense to employ.

Some day we may be able to place electrodes in the brain and produce computer displays that will allow us to improve thinking by comparing our brain activity with that of experts. For the time being we must make do with a simpler technology. Thinking Aloud Pair Problem Solving (TAPPS) is a technique that can help students learn to observe thinking, their own thinking and that of their fellow students. TAPPS makes thinking observable by having a problem solver talk aloud, describing what he or she is thinking. TAPPS makes thinking

sensible by making it audible, and for that reason I will refer to it as *Sound Thinking*. Elsewhere (Lochhead, 2000) I have referred to a similar approach as *Thinkback* emphasising the relationship to video **playback** as used in coaching athletic performance.

Sound Thinking is a tool for teaching and learning thinking. It is not a quick fix. The process of making thinking audible is at first a barrier to optimal performance, and it dramatically slows down the thinking process. But while slow, noisy thinking is not helpful to performance, it is essential for teaching and learning. There is a great deal yet to be learned about this learning - performance trade-off. The most extensive studies to date are those of Ericsson and Simon (1993, 1998)

It takes time and effort to develop skills in *Sound Thinking*, but getting started is quick and easy. Students are paired up and given some simple problems to solve. One student, the problem solver, is asked to talk aloud about everything he or she is thinking while working on the problem. The other student, the listener, listens carefully and asks questions that push the problem solver to describe each step in greater detail. First, the listener makes sure that the problem solver keeps talking: "What are you thinking?" "What is going on in there?". Next the listener looks for gaps in the problem solver's descriptions: "How did you know to do that?" "What are you trying to do now?"

As soon as one problem is solved, the students switch roles and move on to the next problem. They continue to alternate roles while working through a list of problems. This alternation is important because the eventual goal of *Sound Thinking* is to combine skill in thinking aloud with an equal level of skill in listening to thought. With both skills in place students can listen to their own thoughts and understand their own thinking. But to do that, listening and thinking aloud need to be synchronised.[1] Learning two skills in parallel can be confusing. It may be difficult to remember to stay within one role. It is, therefore, important that students start with simple problems that do not demand a great deal of concentration. These problems leave some mental resources available to pay attention to how well one is functioning in the

[1] We have all encountered people, often professors, who are practiced in thinking aloud but not in listening to themselves or others. Their thinking may be untouchably brilliant, but it is not sensible.

role of listener or problem solver. Problems such as those in Chapter Four of the book *Problem Solving and Comprehension* have proven to be most suitable to this purpose.

Before students begin the process of Thinking Aloud Pair Problem Solving it is helpful to provide them with a model case. The following is from *Problem Solving and Comprehension* pg. 36-38 and is reproduced here with permission from the publisher Lawrence Erlbaum

ASSOCIATES

If the second letter in the word *WEST* comes after the fourth letter in the alphabet, circle the letter A below. If it does not, circle the B.

A **B**

PROBLEM SOLVER

If the second letter in the word *WEST* comes after the fourth letter in the alphabet, circle the letter A below. If it does not, circle the B.

LISTENER

You said "in alphabet" not " in the alphabet."

PROBLEM SOLVER

Oh, yeah. (pause).

LISTENER

What are you thinking?

PROBLEM SOLVER

Nothing. I am just looking at it.(pause).

LISTENER

What are you looking at?

PROBLEM SOLVER

It's A.

I circle the A.

LISTENER

Wait a minute.

You just said you weren't thinking. Now you say it's A. How did you get that?

PROBLEM SOLVER

Well, the fourth letter is D.

LISTENER

Yes.

PROBLEM SOLVER

And so I circle the A.

LISTENER

How do you get the fourth letter is D?

PROBLEM SOLVER

A, B, C, D. I count.

LISTENER

OK. So how come you circle the A?

PROBLEM SOLVER

Because that's what it says to do.

LISTENER

I think you're wrong.

Here the listener deliberately lies. The earlier attempts to get the problem solver to think aloud failed to produce much. But forcing the problem solver to defend his thinking against unjustified criticism finally breaks through this silence.

PROBLEM SOLVER

I am wrong?

(pause)

You mean it is B.

It can't be B because the letter E comes after the letter D.

LISTENER

Yeah?

PROBLEM SOLVER

And it says that if the second letter in *WEST*, which is *E*, comes after the fourth letter in the alphabet circle the A. So I did.

LISTENER

Yes, but E comes before H, which is the fourth letter in alphabet.

PROBLEM SOLVER

Hmm. You think they want the fourth letter in alphabet?

(pause)

No they don't!

They said *the* alphabet not in alphabet. You pointed that out to me earlier.

LISTENER

Oh.

PROBLEM SOLVER

So it's A.

LISTENER

Wait, tell me all over why you think it is A.

Go slowly.

PROBLEM SOLVER

Well, the problem asks you to circle the A if the second letter in *WEST* which is *E* comes after the fourth letter in the alphabet which is D. And *E* comes after D so I circle the A.

LISTENER

Are you sure?

PROBLEM SOLVER

Yes.

As students gain experience, listeners should ask questions that probe the problem solver's thinking, pushing for ever more detailed descriptions of each thought. At the same time, problem solvers will find that they have begun to ask listener-like questions of themselves and, therefore, can provide details even without the assistance of an active listener.

The culmination of *Sound Thinking* is reflective thinking, the ability to listen to and follow one's own thought processes. To reach this stage, students need to have internalised the two roles of listener and problem solver to such an extent that each is automatic. Students who have reached this stage are in a position to learn from their own mistakes. They know what route they took to get to a wrong answer, and they can go back and figure out where they

went wrong. They are also able to learn from the performance of fellow students or from expert models. When they do not understand a process they are observing, they know how to ask questions to illuminate it. In short, they are no longer playing in the dark.

TEACHING WITH THINKBACK

Reflective thinking is essential to metacognition, the process of thinking about thinking. We can understand another person's thinking only to the extent that we can model it with our own thinking. Thus, as long as our own thoughts remain opaque, the thoughts of others are even more obscure. Without reflective thinking we remain lost in a mental fog that we cannot see and have no reason to believe exists. Therefore until we can think reflectively, we have no idea what we have been missing.

The process of *Sound Thinking* as implemented in *Problem Solving and Comprehension* improves student performance on a wide variety of tests. About 40 hours of instruction can produce gains averaging 10% on tests such as the SAT. But these gains understate the potential. When *Sound Thinking* is used as part of a coherent thinking skills programme the outcomes can be astounding. There are many ways to implement such a programme. Xavier University in New Orleans has one approach; Morningside Academy in Seattle has quite a different one. When *Sound Thinking* is used in an educational environment that stresses many different approaches to developing thinking skills, it becomes a powerful tool for improving learning. Because *Sound Thinking* teaches students to think reflectively, it helps them get the most out of other methods for teaching thinking. To produce the best results, a programme needs to employ several different methods for teaching thinking, and do this in a total educational environment that demands and rewards serious thinking.

At Xavier University in New Orleans, the TAPPS process has been used for over 20 years as part of a comprehensive approach to improving thinking skills. During these years medical school acceptances have increased over 3000%. In just two decades Xavier has lifted itself from a position of no academic distinction to become one of the top 30 universities in the United States.[2]

[2] There are only 30 institutions in the United States that place over 100 students per year into medical school. Most are very large university complexes containing a vastly greater faculty and student body than Xavier has.

The Morningside Academy in Seattle has been using TAPPS for over 15 years in the middle school and high school years. It has repeatedly measured learning gains many times greater than normal. Student performance on the Iowa Test of Basic Skills consistently rises 2 to 5 grade levels after a single year of instruction. An adult version of the Morningside programme used in Welfare to Work programmes produces one grade level of change for each month of instruction, roughly ten times the normal rate of learning.

Long term use of *Sound Thinking* accomplishes much more than merely improving students' learning capabilities. Because *Sound Thinking* allows teachers to hear how their students think, it permits teachers, probably for the first time in their careers,[3] actually to observe student thinking. Normally teaching is conducted, like night tennis, without any clear sense of the impact of one's actions. With *Sound Thinking* the rules are changed; everything is different. For institutions such as Xavier and Morningside this difference in faculty vision has created gains far beyond what is normally possible. And these gains have multiplied year after year after year.

But the greatest benefits require much more than just the long term use of *Sound Thinking* alone. The gains at Xavier and Morningside are produced because *all* faculty were involved. While the practice of *Sound Thinking* may help one teacher to see students in a new light, such benefits are limited when other colleagues remain in the dark. Large educational gains demand a comprehensive, well-integrated approach where all faculty strive for common goals. Team performance will be erratic if most of the players cannot see the goal posts.

Even with *Sound Thinking*, much mental activity remains hidden or obscure. The image of thinking that emerges from thinking aloud (even highly practiced thinking aloud) is often blurry and open to extensive interpretation. Learning to interpret such blurry images is best

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While Xavier is in the top 30 only in terms of medical school placements, there has also been remarkable growth in other disciplines.

[3] This claim may seem a little outrageous. To remain sane, teachers must assume that they can understand their students' thinking. Without the listening skills developed by *Sound Thinking* (or some equivalent approach), teachers will be unaware of what they are missing.

accomplished in a community of colleagues who can challenge and defend various constructions. The task of making thinking sensible needs to be a school-wide effort.

THINK WRITE

After students have internalised the listener role and are comfortable with detailed loud thinking, they are ready for the more challenging task of *Write Thinking*. In this exercise (usually assigned as homework) students write out everything they would have said to their partner. *Write Thinking* has many advantages, but it is quite difficult to learn. First, it requires a thorough mastery of *Sound Thinking*. Next, it requires the persistence to put thoughts into writing, a medium that is both slower and more taxing than speech. To date few teachers have had the skill and determination to demand *Write Thinking* from all of their students. But for those fortunate students who learn to use *Write Thinking*, the long term advantages are considerable. An engineering student explained, "Whenever I see an exam question that I have absolutely no idea how to solve I start to use *Write Thinking*. At least I can get some partial credit. But, usually once I start writing, I discover I know how to solve the problem." Sensible thinking, whether in writing or speech, gives access to powers we never sensed before.

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